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OCTOBER 2024

Intelligent data-driven energy management

Data usage in the energy project at Michelin

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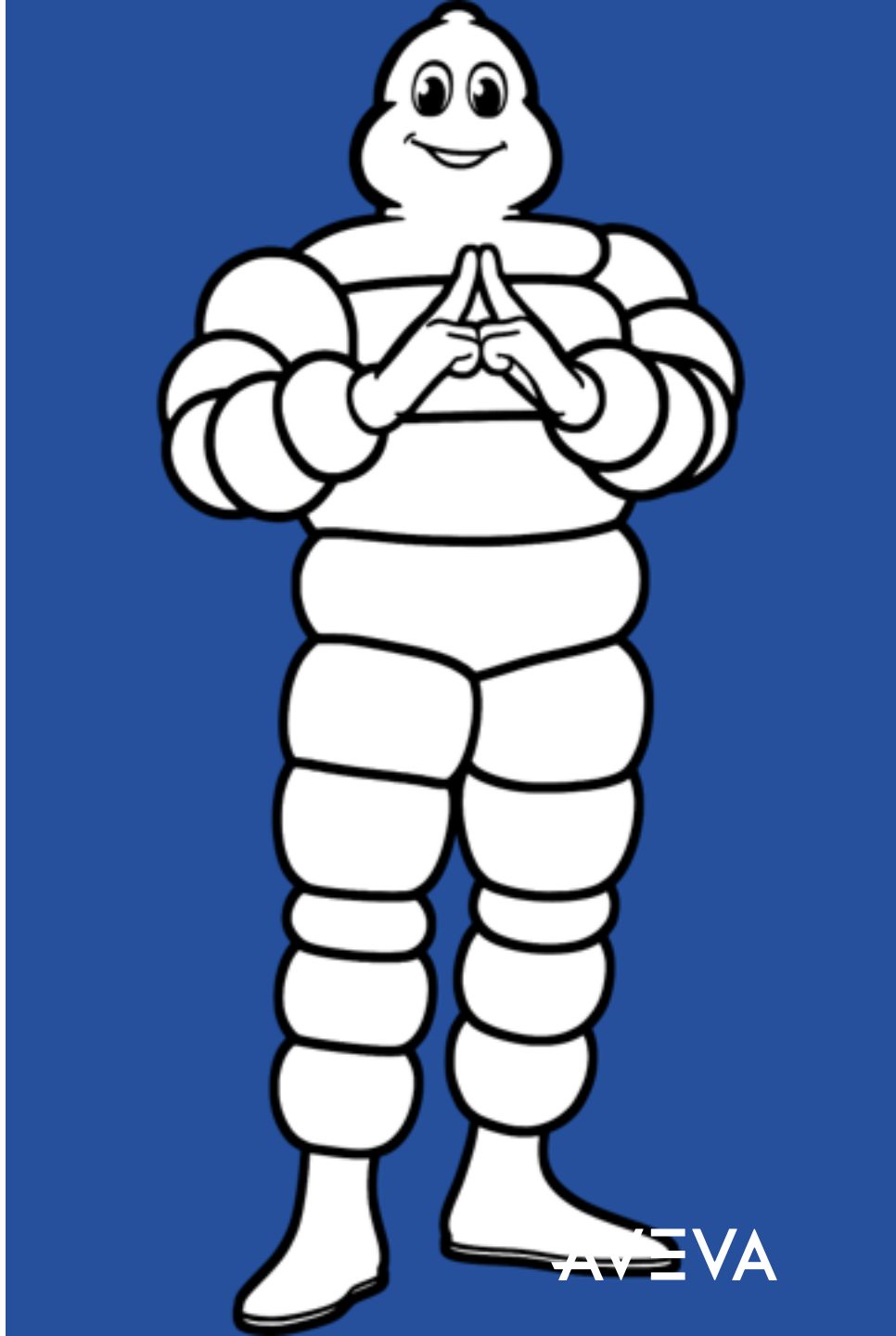
Michelin progresses toward sustainability

Challenges

- Standardize energy data from multiple sources for easier use outside operations.
- Process huge amount of data.
- Make energy consumption monitoring accessible to everyone in the company.

Solution

- Use AVEVA PI Server and Asset Framework functionality combined with Michelin solution (Mapib) to read, standardize and contextualize data from each counter.
- Process data in the cloud and expose in a standard way for users.
- Develop a mobile app to offer quick and easy data access to everyone.



Why the Energy product ?

- **Simplify** Measurement
- **Simplify** Analysis
- **Alert** Proactively

Improved productivity & well being

PEOPLE ⟷ ***PROFIT***

PEOPLE ↘ ***PLANET*** ↙ ***PROFIT***

- **Reduce** Energy consumption
- **Optimize** Processes
- **Control** Energy Providers

3% reduced consumption

- **Reduce** CO2 Footprint

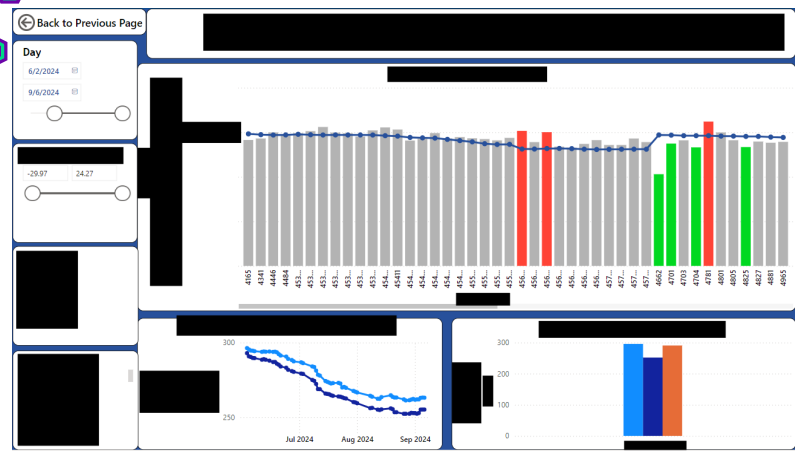
120 KT / year

A tool for each usage

Monitor, React

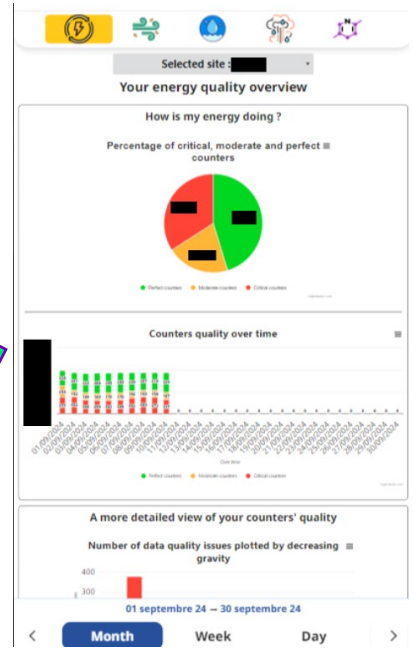
A few minutes

Understand, Correct, Optimize



A few hours

Share, Decide



A few days

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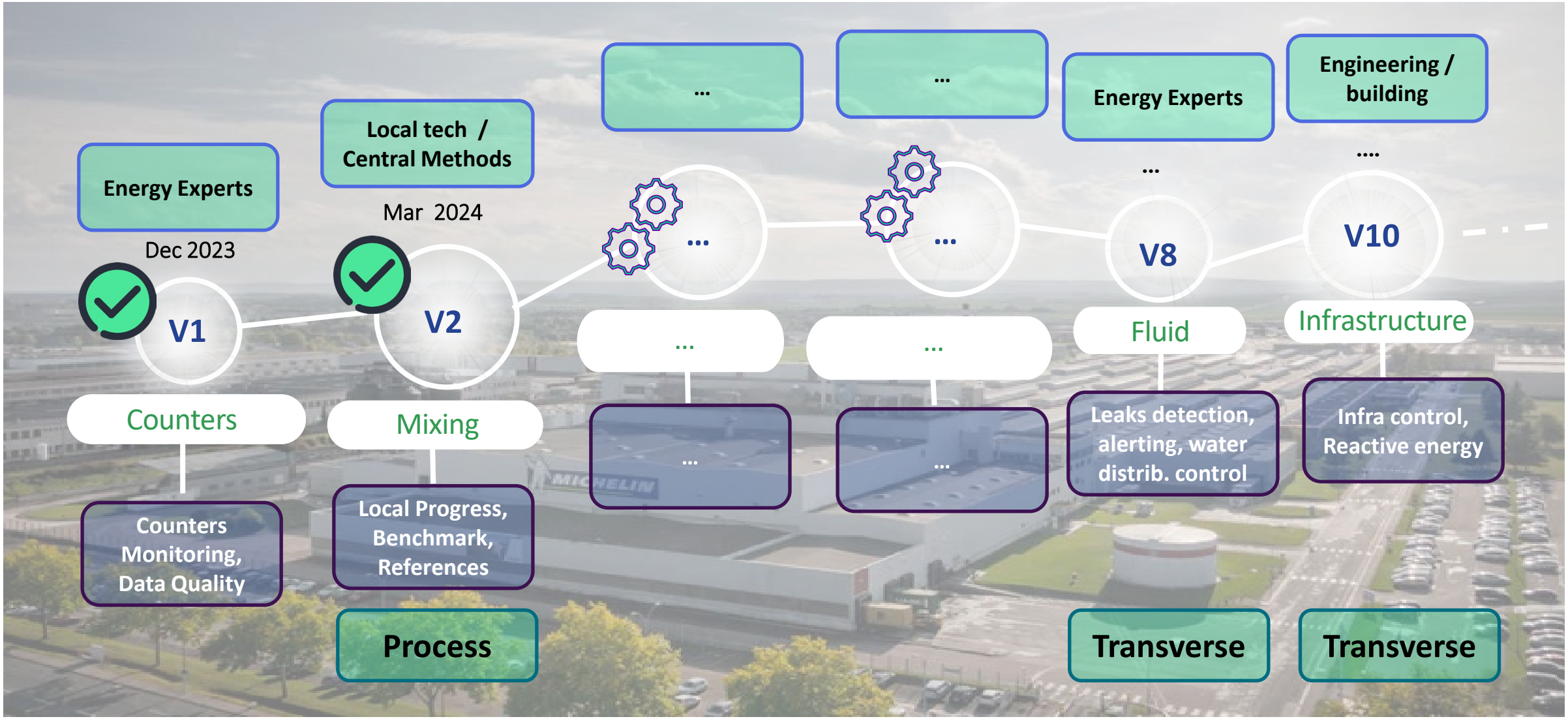
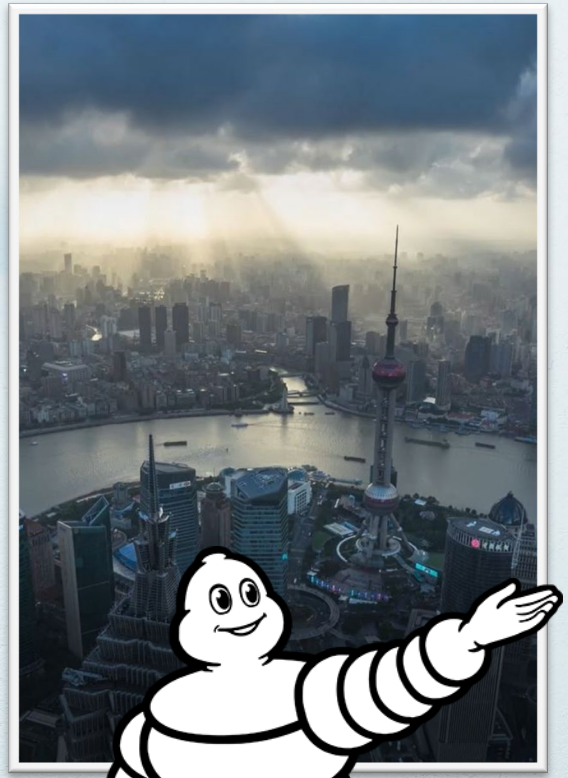
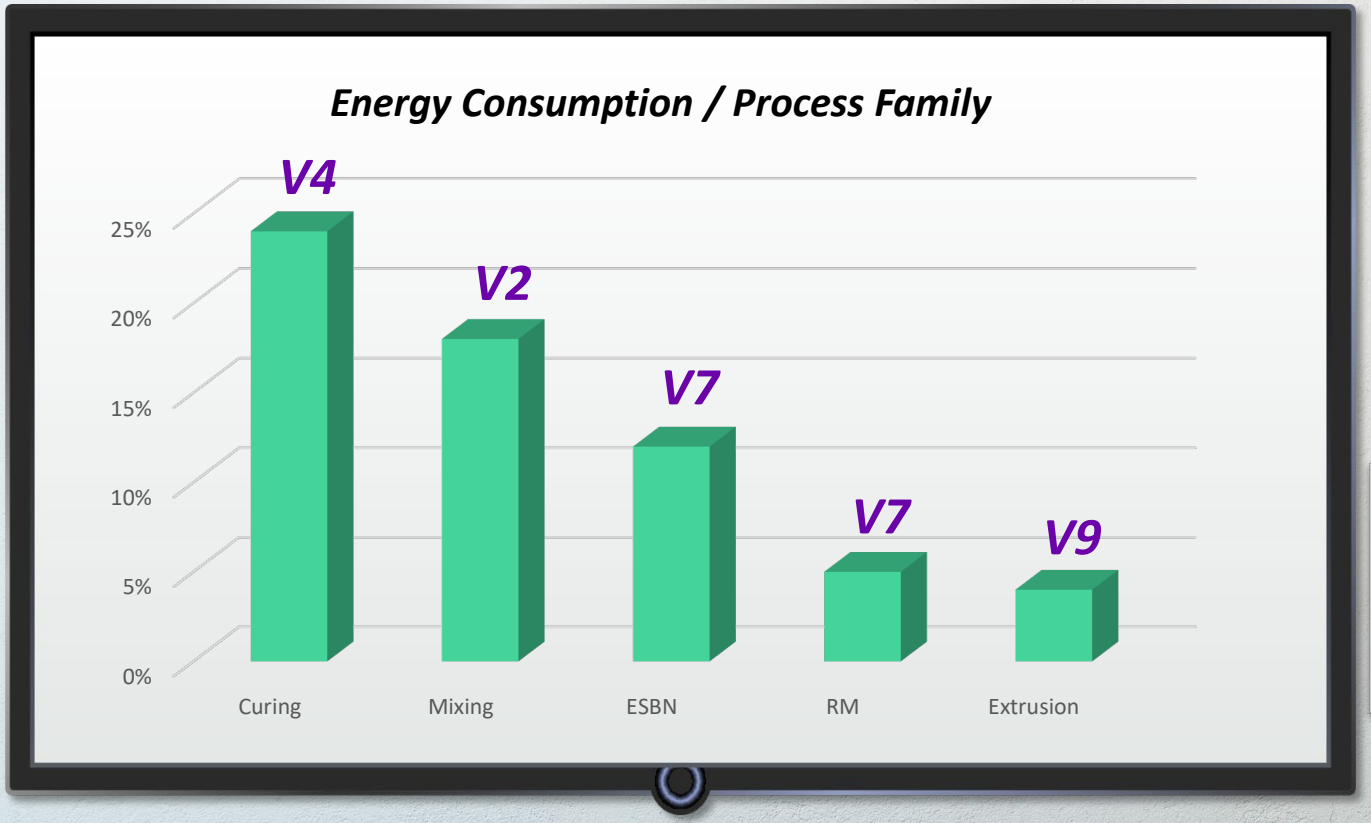
Michelin product roadmap






Energy Consumption / Process Family
25%
20%
15%
10%
5%
0%
V4
V2
V7
V7
V9
Curing
Mixing
ESBN
RM
Extrusion

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Energy product challenges and KPI

Key Drivers

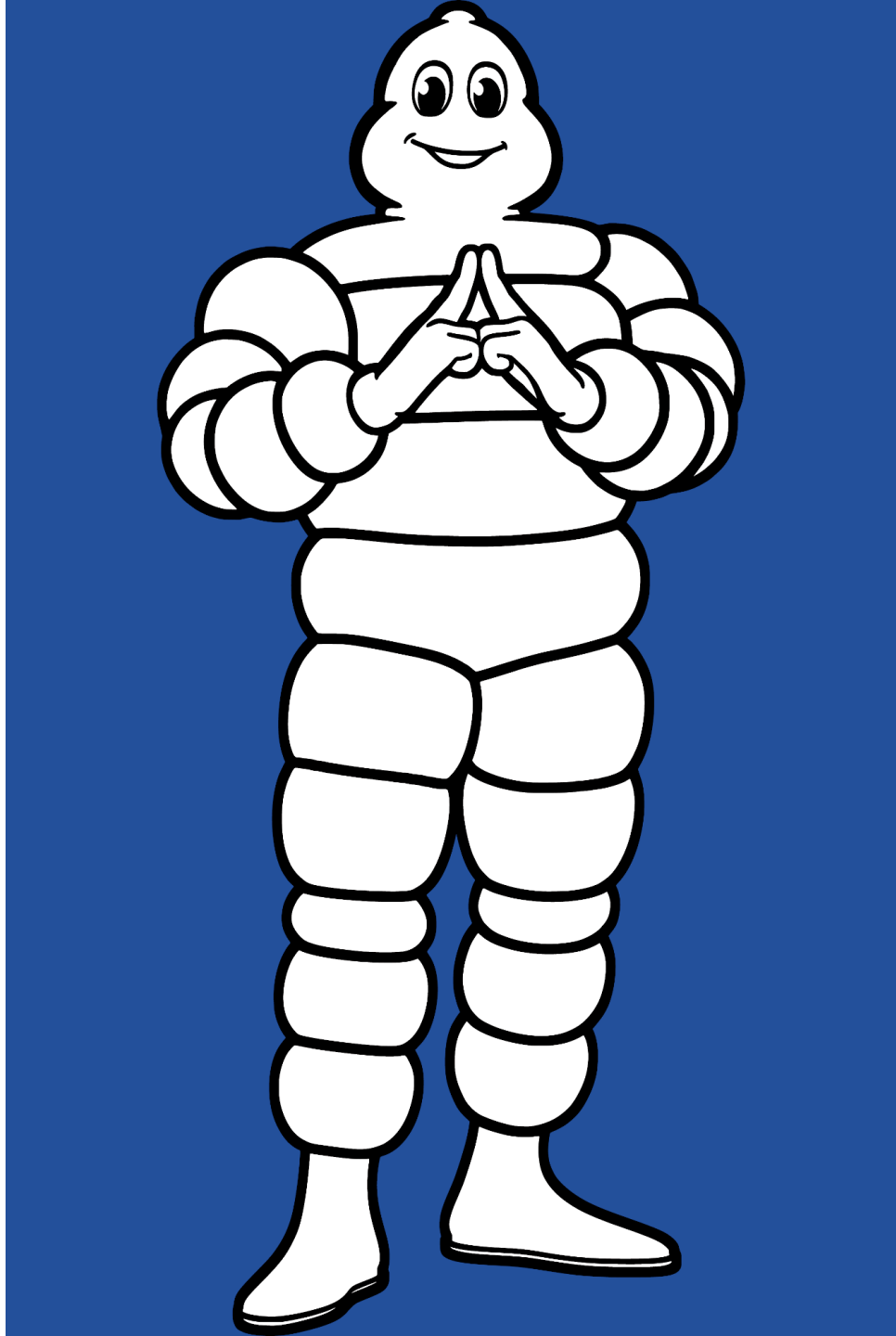
- Each employee is aware of energy consumption
- Each employee is an actor of energy sobriety
- Energy becomes a manufacturing KPI

Key features

- Monitoring
- Alerting
- Prescription
- Optimisation

Key Challenges

- *Fast scale up*
- *Cross data between factories*



Energy data from counter to cloud

Expectation versus reality

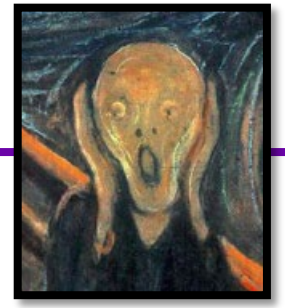
Expectation

P(kWh)

__ActiveEnergy_Export(kWh)

Reality

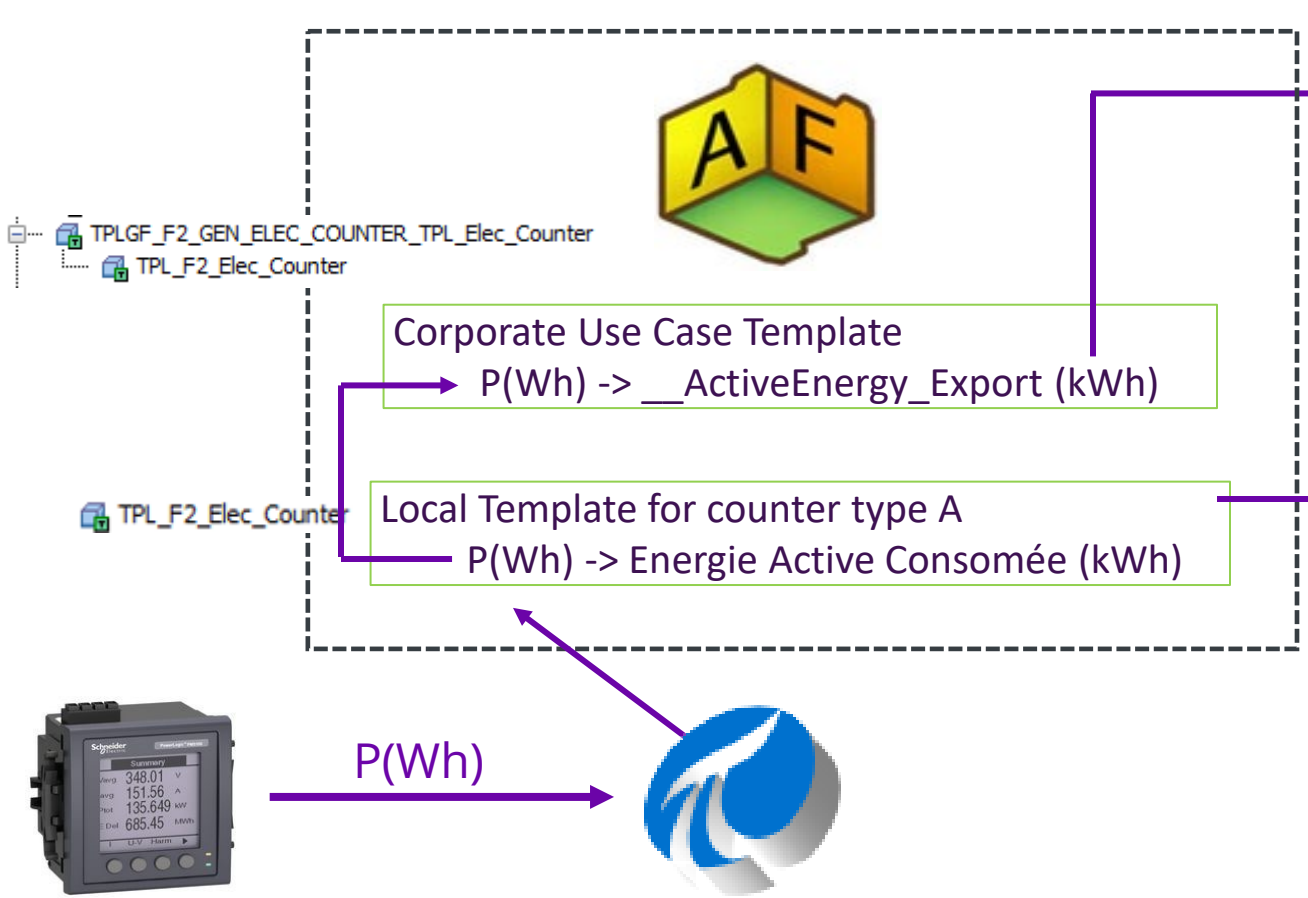
x 100,000 counters
Over 70 factories

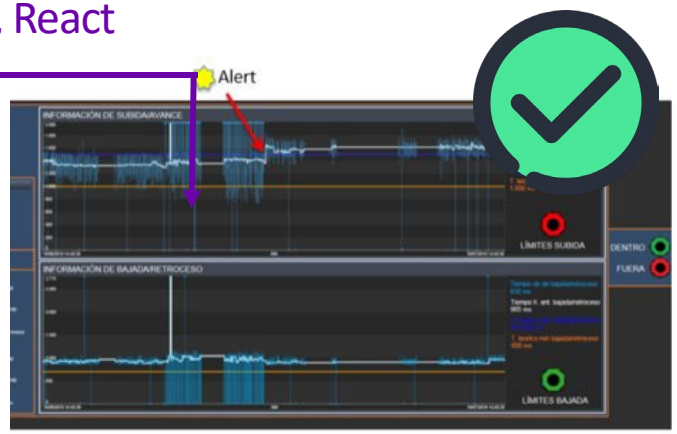


Standardizing energy data

Standardize data using AVEVA PI Asset Framework

The use of linked use case templates allows us to standardize information without changing anything on sites local function.





Local AVEVA PI Vision Screens

Standardizing energy data at large scale

Michelin standard tool: MAPIB

Local Template

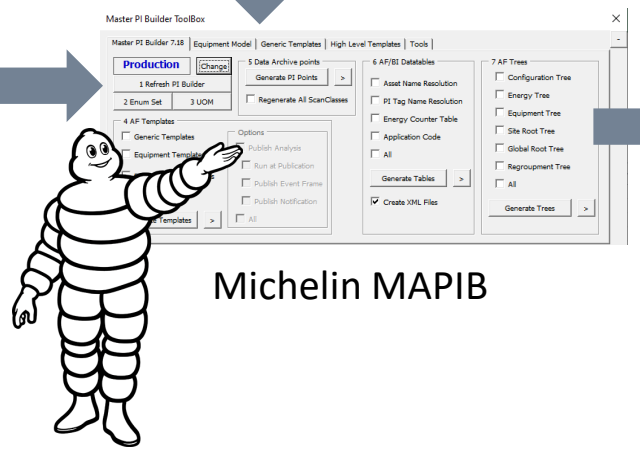
Template Name	Attribute name
TPL_F2_Elec_Counter	
TPL_F2_Elec_Counter	P_Tot_Export
TPL_F2_Elec_Counter	P_Tot
TPL_F2_Elec_Counter	P_Inst
TPL_F2_Elec_Counter	Running

Corporate Use Case Template

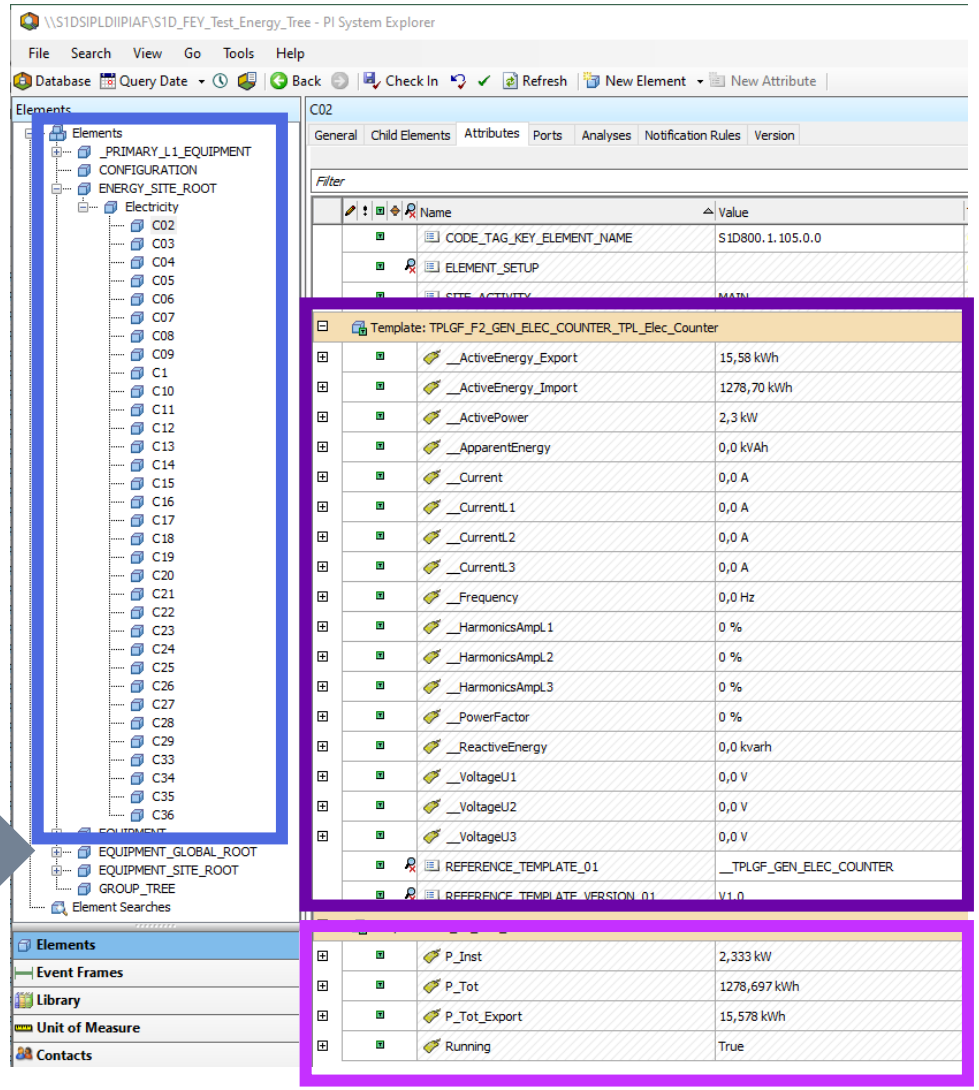
__TPLGF_GEN_ELEC_COUNTER	
__TPLGF_GEN_ELEC_COUNTER	__VoltageU1
__TPLGF_GEN_ELEC_COUNTER	__VoltageU2
__TPLGF_GEN_ELEC_COUNTER	__VoltageU3
__TPLGF_GEN_ELEC_COUNTER	__Current
__TPLGF_GEN_ELEC_COUNTER	__CurrentL1
__TPLGF_GEN_ELEC_COUNTER	__CurrentL2
__TPLGF_GEN_ELEC_COUNTER	__CurrentL3
__TPLGF_GEN_ELEC_COUNTER	__Frequency
__TPLGF_GEN_ELEC_COUNTER	__PowerFactor
__TPLGF_GEN_ELEC_COUNTER	__ActivePower
__TPLGF_GEN_ELEC_COUNTER	__ActiveEnergy_Import
__TPLGF_GEN_ELEC_COUNTER	__ActiveEnergy_Export
__TPLGF_GEN_ELEC_COUNTER	__ReactiveEnergy
__TPLGF_GEN_ELEC_COUNTER	__ApparentEnergy
__TPLGF_GEN_ELEC_COUNTER	__HarmonicsAmpL1
__TPLGF_GEN_ELEC_COUNTER	__HarmonicsAmpL2
__TPLGF_GEN_ELEC_COUNTER	__HarmonicsAmpL3

	Body			Template
SITE	L0_Area	L1_Process_Cell	L2_Unit	Template Name
S1D	Energy			
S1D	Energy	Electricity		__TPLGF_TPS_Electricity
S1D	Energy	Electricity	C26	TPL_F2_Elec_Counter_Fast
S1D	Energy	Electricity	C33	TPL_F2_Elec_Counter_Fast
S1D	Energy	Electricity	C1	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C02	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C03	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C04	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C09	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C10	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C14	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C15	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C17	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C16	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C11	TPL_F2_Elec_Counter
S1D	Energy	Electricity	C36	TPL_F2_Elec_Counter

Local Counter List



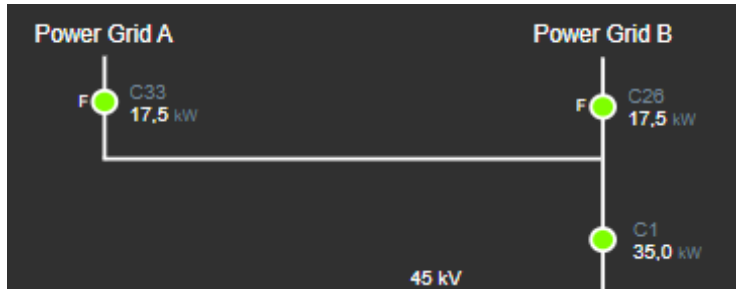
Michelin MAPIB



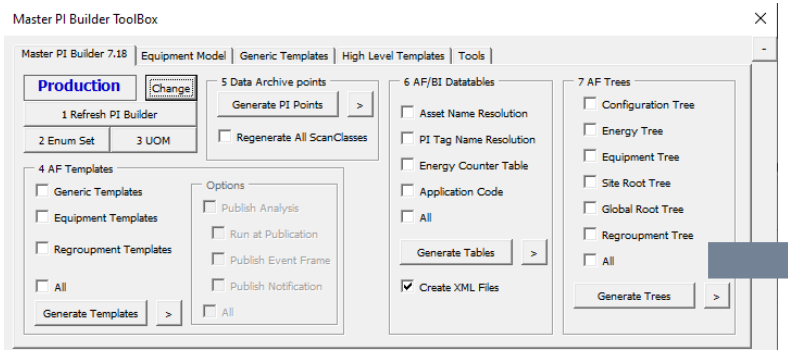
Link energy data to its context

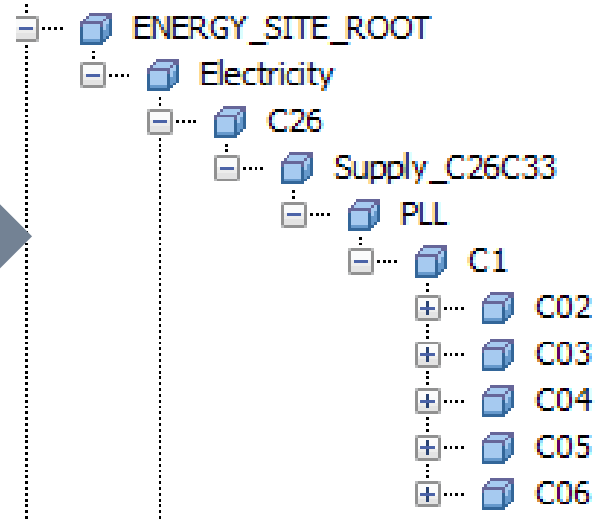
Relationship between counters

- We have defined a method to describe the relation between counters in the counter list.
- Local team can reproduce the exact schematics in the PI Asset Framework hierarchy.



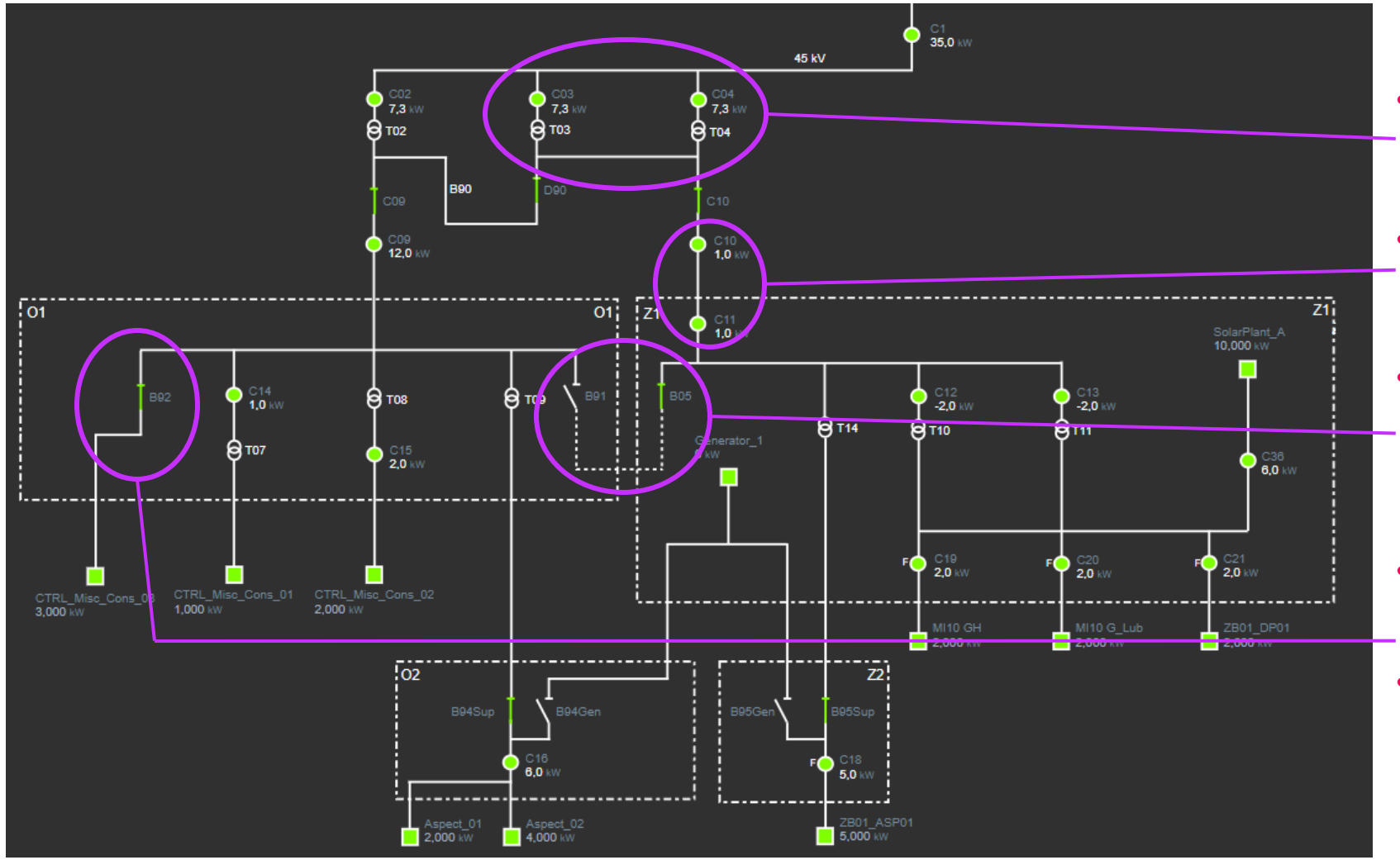
L1_Process_Cell	L2_Unit	Parent_Ref
Electricity		Energy
Electricity	C26	Electricity
Electricity	C33	Electricity
Electricity	Supply_C26C33	C26;C33
Electricity	C1	Supply_C26C33





Adding a layer of intelligence

Context to scale logical tests helping decision making



- Model consistency check:
  - C03 ≠ C04 -> Error
- Leak detection:
  - C10 > C11 -> Leak
- Detect model modifications:
  - B91 not Active -> Use Model 1
  - B91 Active -> Use Model 2
- New counter installation:
  - B92 > 20% of C09 -> Install New Counter
- Virtual counter extrapolation:
  - B92 = C09-(C14+C15+C16)

Organizing energy data context

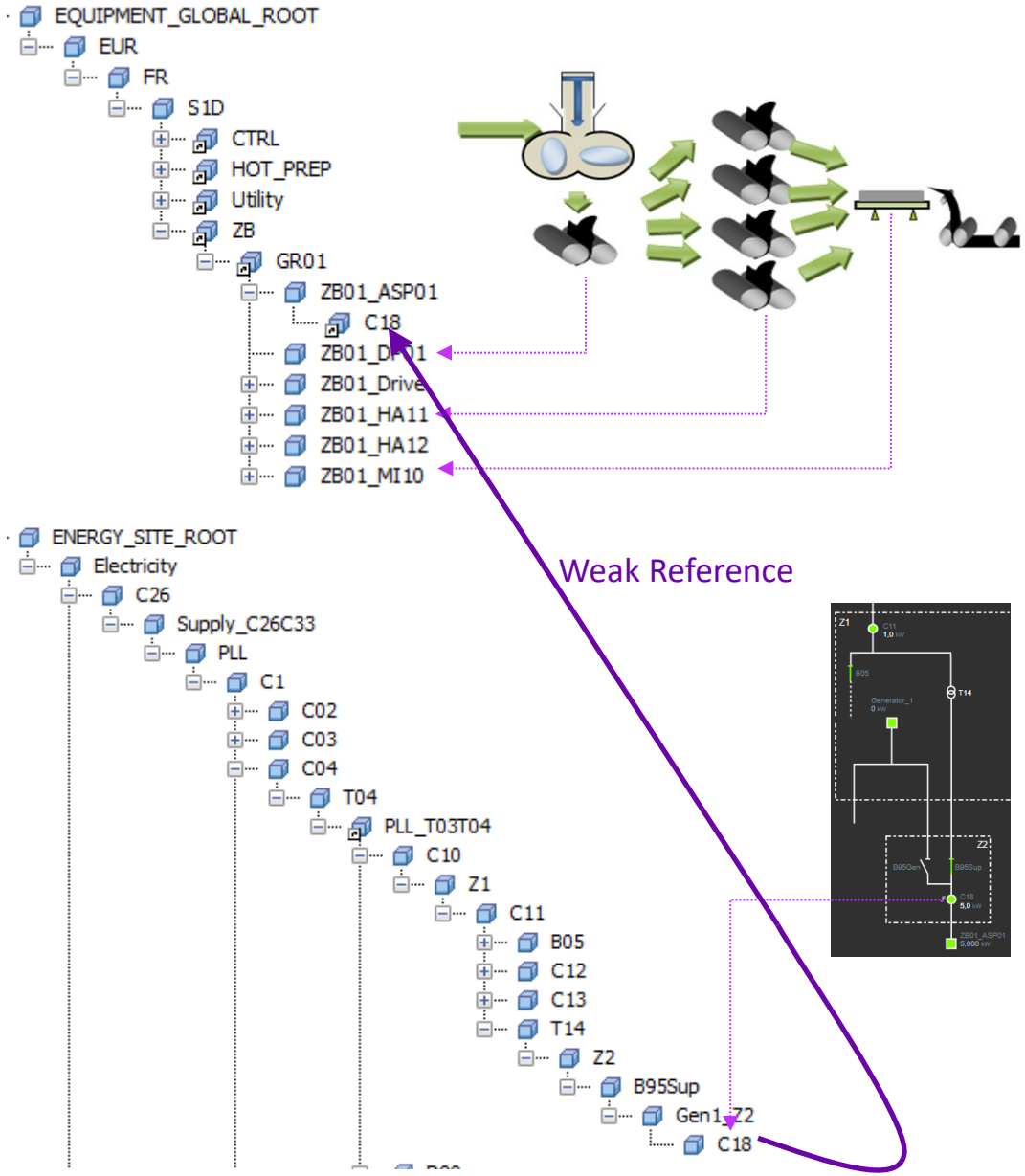
Position of counters

Production asset tree (hierarchy)

- Each Production Asset is modelized in the Equipment Tree using templates to organize its production data
  - Sensors
  - Context information (Localization, IT references)
  - Product identification…

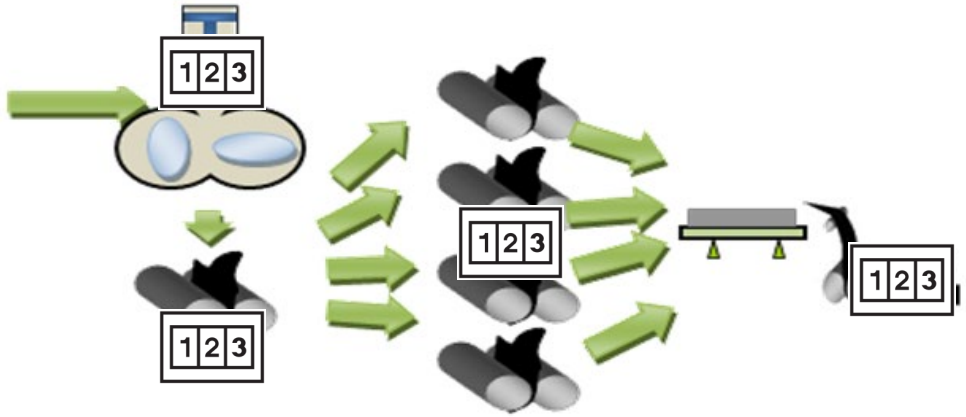
Energy tree (hierarchy)

- Using PI asset framework Weak reference, we can link counters and Production assets.



Associate energy data to process/equipment

Enabling use cases beyond usual scope



- Machine Data:
  - Batch ID
  - Batch weight
  - Running Status (Run, Wait, Stop)
- Energy Data:
  - Energy Consumption

Crossing information gives the quantity of energy used to create this batch

- **Usage in industrial operations**:
  - Comparison of energy consumption between model and machine.
  - Optimization of machines in relation to energy/quality.
- **In maintenance**:
  - Definition of a target model by Batch ID (drift detection).
  - Machine / operation consumption comparison.
- **In financial management**:
  - Prediction of energy consumption to buy energy in the open market.
  - Real cost of energy used to manufacture one product.
- **In production management**:
  - Planning with energy KPI.

Cloud data platform

Provided by:
Thomas Bailly
Cloud Expert

Data gathering
(70 factories)

Site 1 | Site 2 | Site 3
Site 4 | Site 5 | Site 6
Site 7 | Site 8 | Site 9

- *Standardization through the use case template and the energy tree*

Data processing
(less than 2 hours)

Azure Data Factory

Trigger

ADLS Gen 2
Delta Table

Storage

databricks

- *Distributed compute using plural workers*
- *Designed for acceleration and optimization*

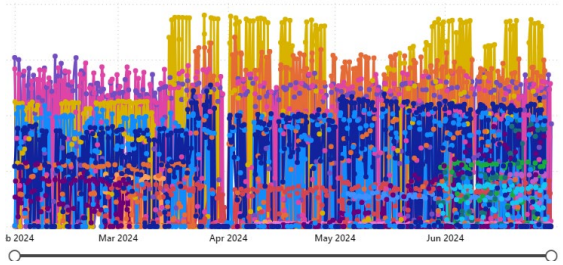
Data delivery
(less than 20 secondes)

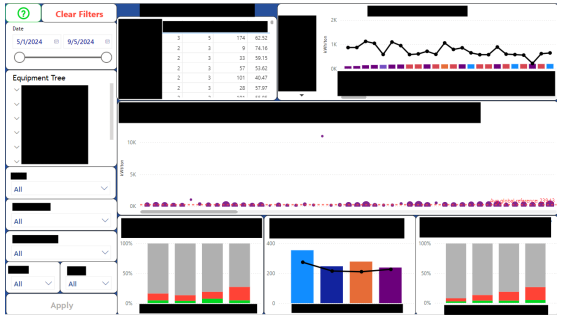
Databricks
SQL Warehouse

Exposed

Power BI

- *15 Machines HxH Cons for 4 months => **8s***
- *Benchmark on 8 Machines operations for 3 months => **18s***





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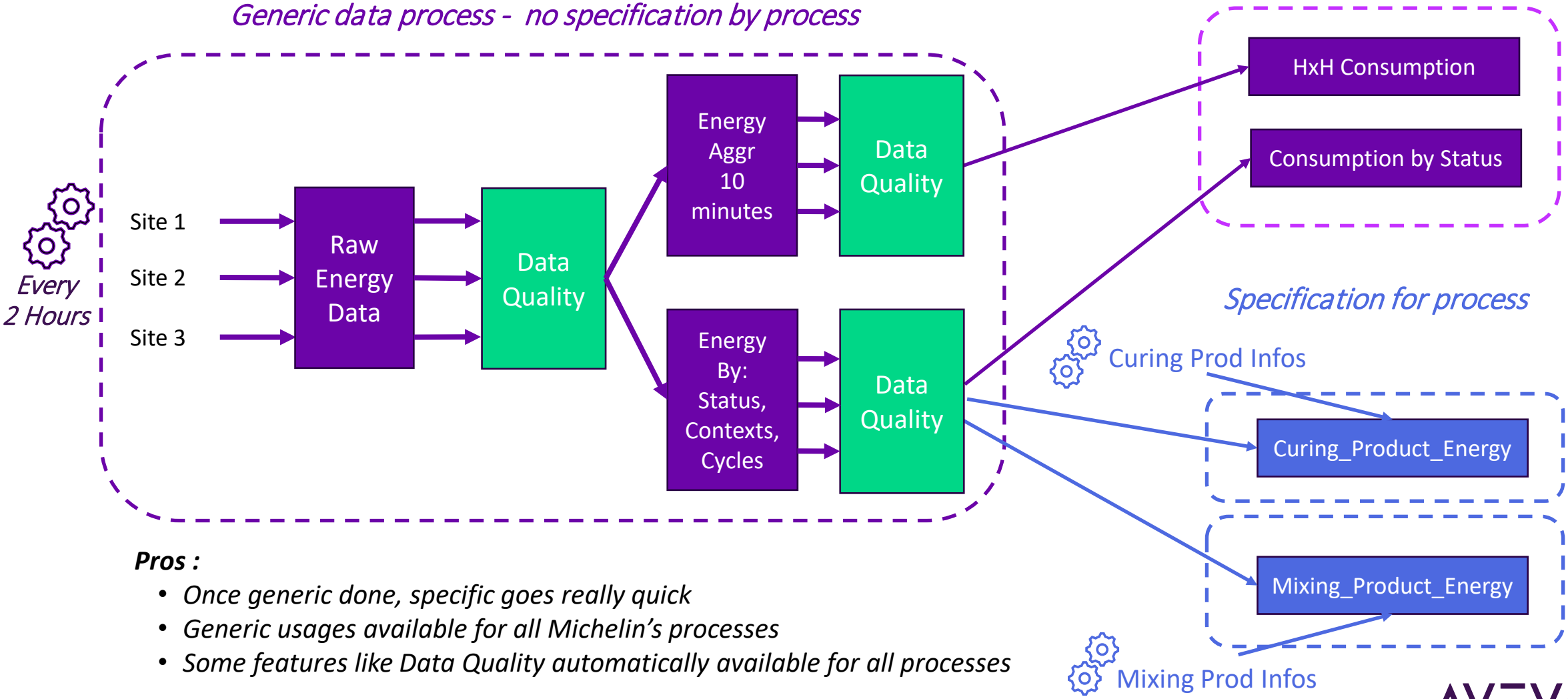
Solution design for acceleration data platform

Provided by:
Olivier Bertin
Data Engineer

Generic data process - no specification by process



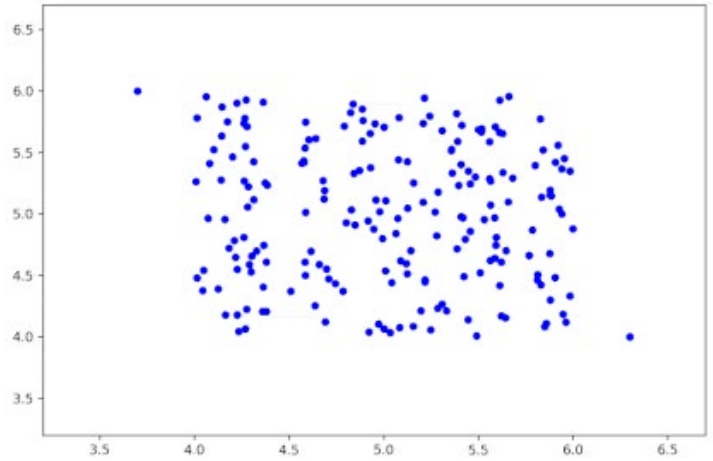
Pros :

- *Once generic done, specific goes really quick*
- *Generic usages available for all Michelin's processes*
- *Some features like Data Quality automatically available for all processes*

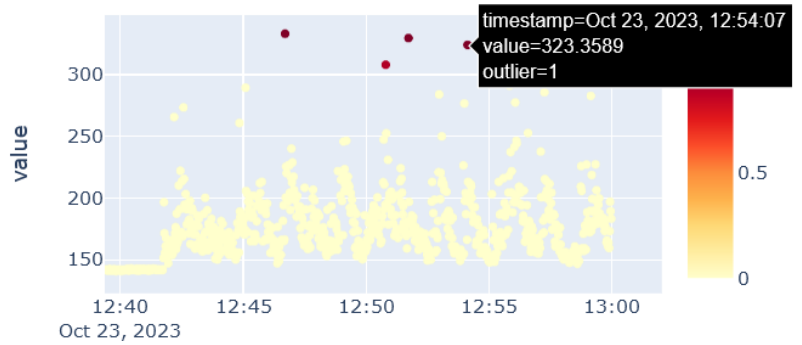
ML-based data quality

Provided by:
Martin Esnault
Data Scientist

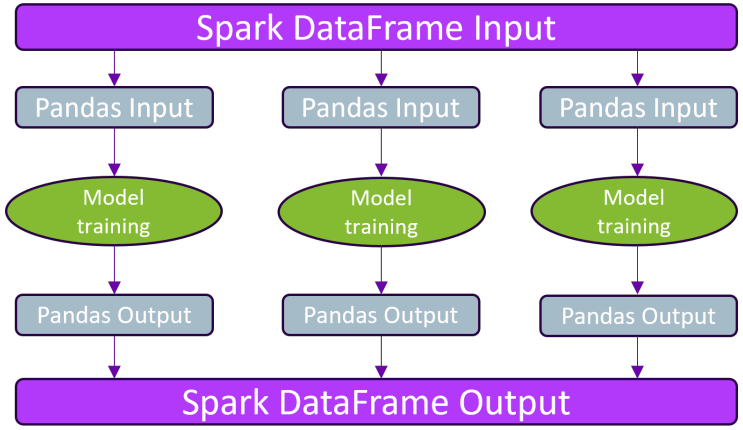
Isolation forest: Machine Learning algorithm to detect unconsistent values



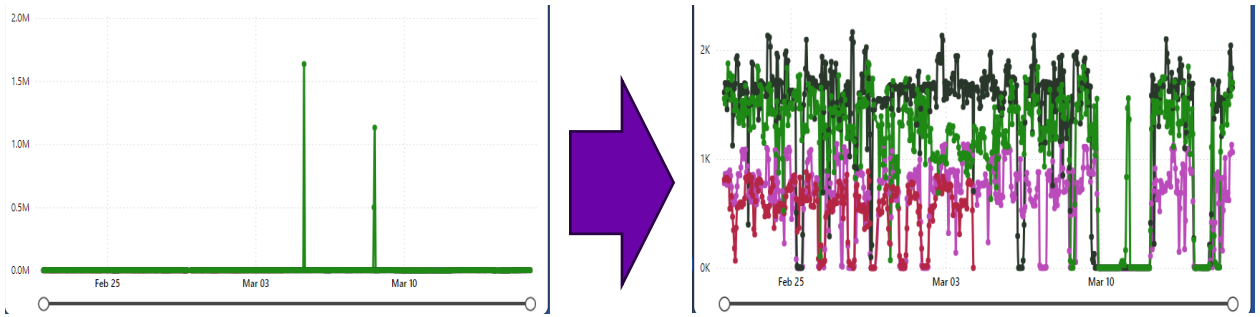
Data scoring : Once a value is detected, we score it based on its gap from the average (0 is Good, 1 is Bad)



Parallelize training of 30,000 models every two hours.



Keep only high quality data to eliminate signal noise.



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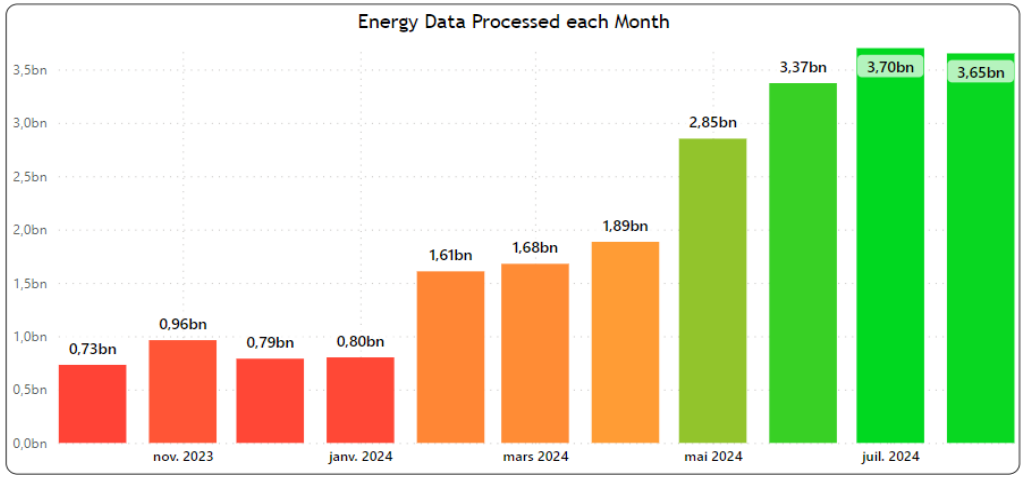
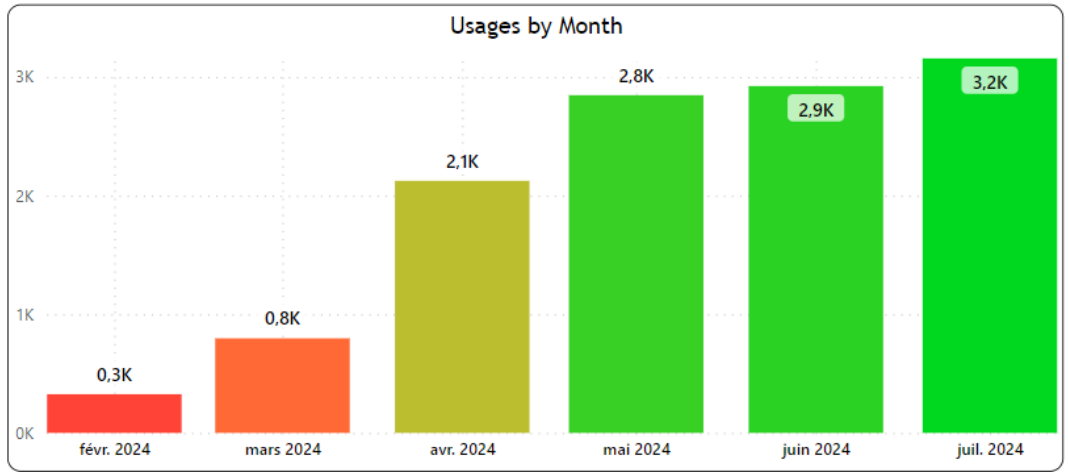
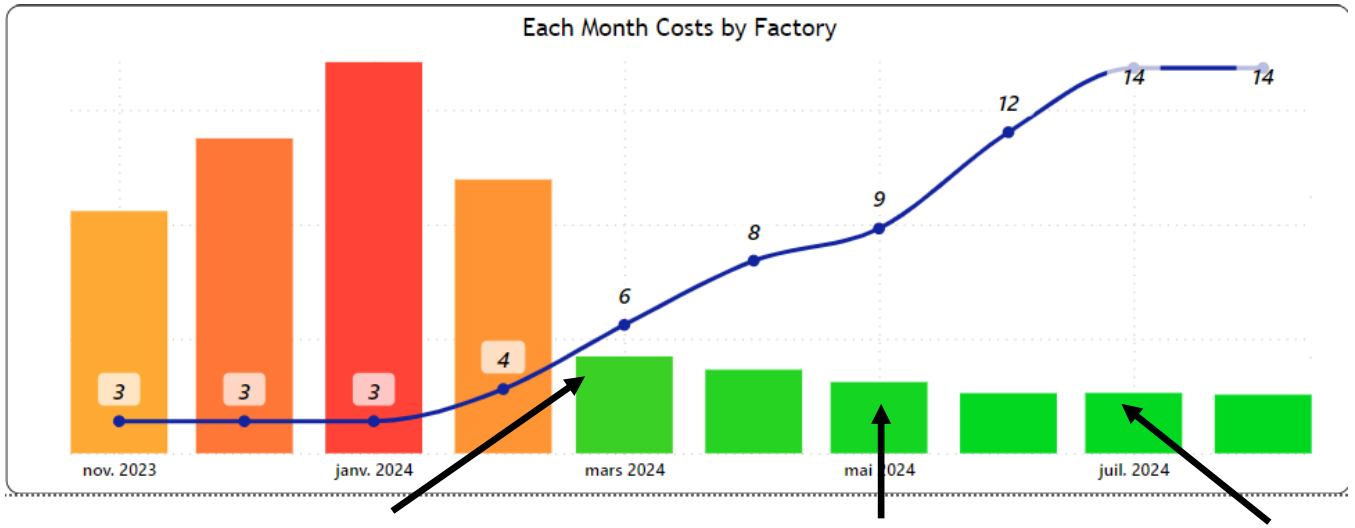
More usage, same cost







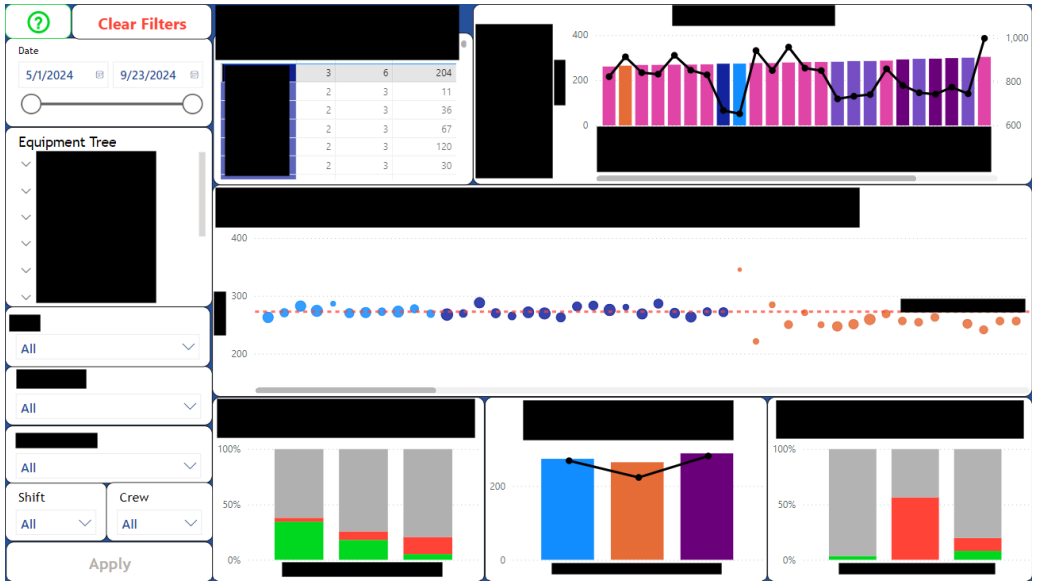
- *Total monthly cost :*
  Less than 5K€
- *Monthly cost by factory :*
  Less than 350€

Infra optimization

Data quality parallelization

Aggregation mutualisation

Success in mixing



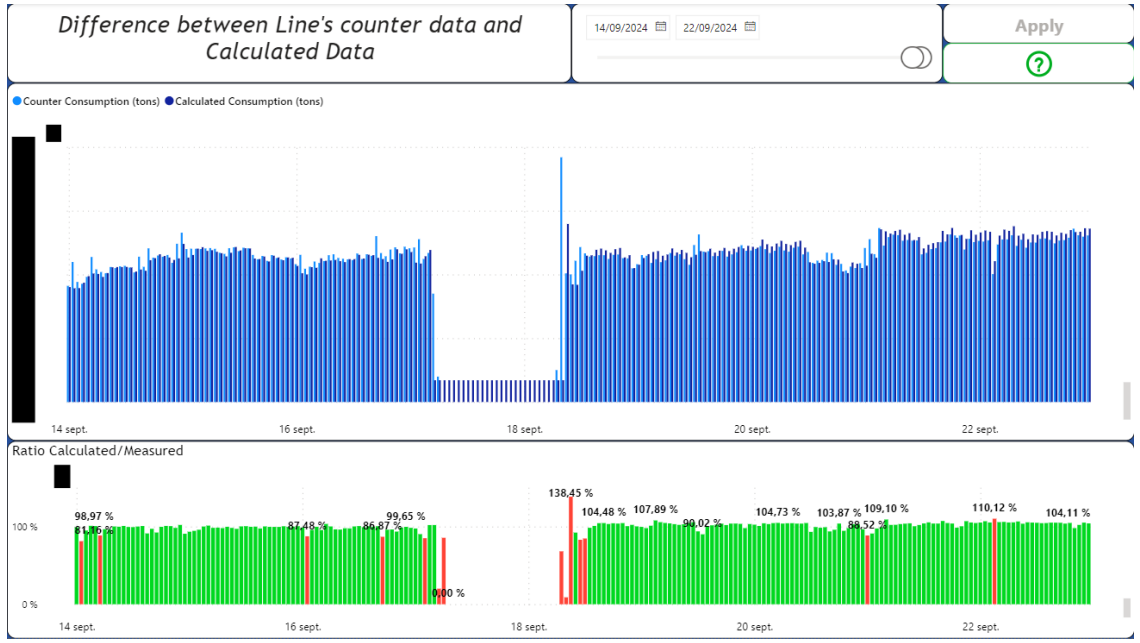
Monitoring production energy consumption (local)

- *Reduction by 10% of speed on one process, without any impact on products quality, causes a **10% reduction** of consumption.*
- *Local optimization on process parameters **(3 to 5%)***

Benchmarking between machines (central)

- *Find the best process parameters combination for the same type of products (**up to 16% of savings**).*
- *Compare different machines on same type of production (**up to 10%**).*

Success in curing

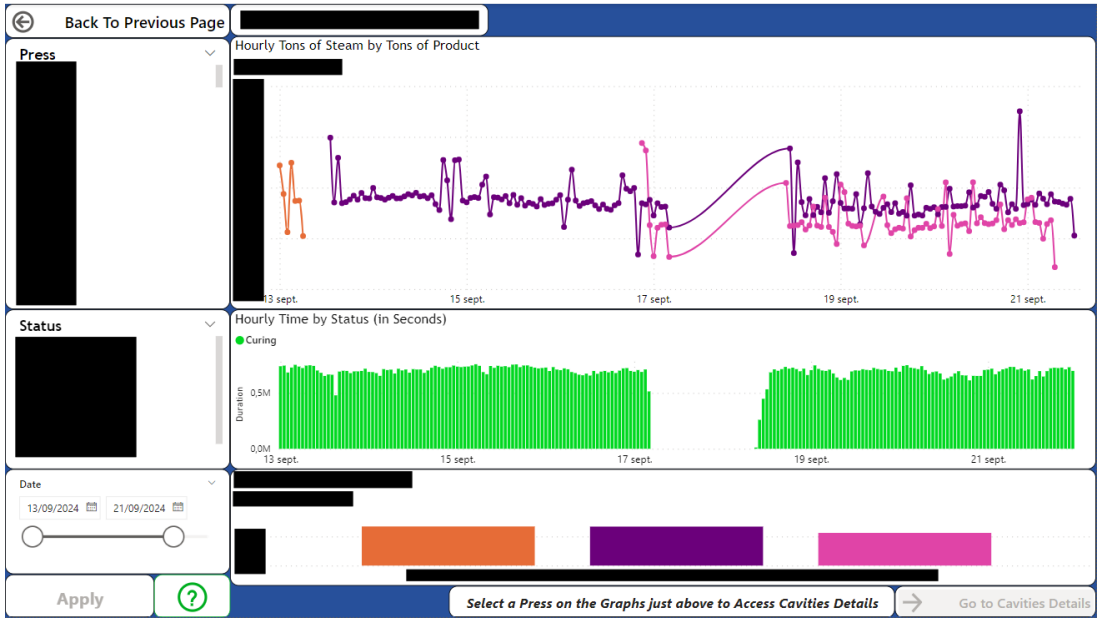


Benchmarking between machines (central)

- Steam consumption at press levels allow us to compare different machines on same type of production. (**not possible before without counting at press level**)

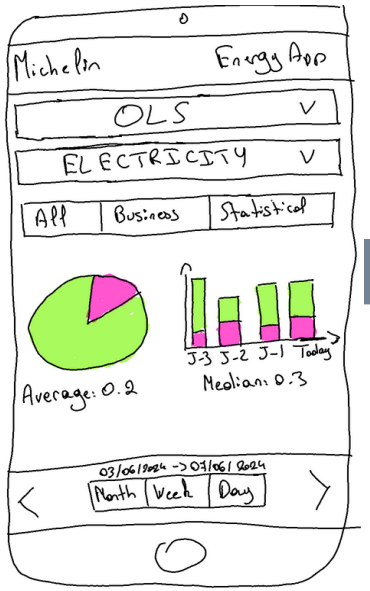
Steam consumption at cavity level (local)

- Calculation of steam consumption at valve level in PI => Allow calculation and follow of consumption by curing press for **0 Capex**.
- Overall, **less than 10% of difference** between the sum of valve's calculated consumption and real counter online for presses (120 valves by line).

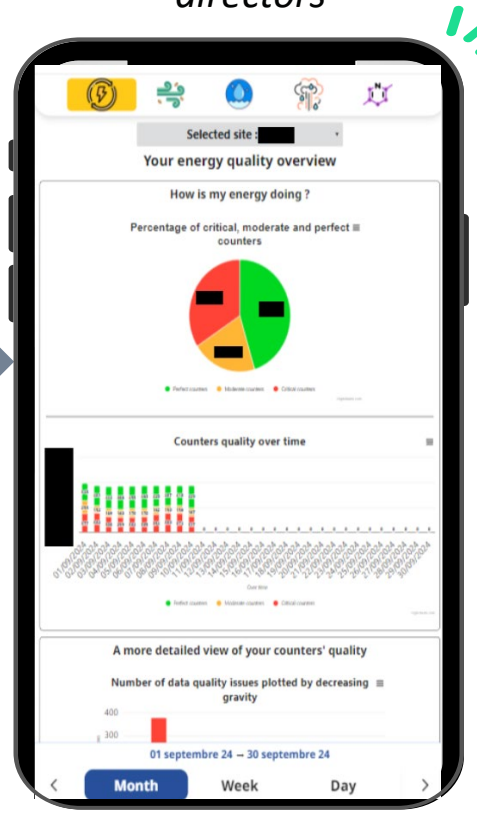


All Michelin employees now ‘energy sobriety actors’

Accessibility solution

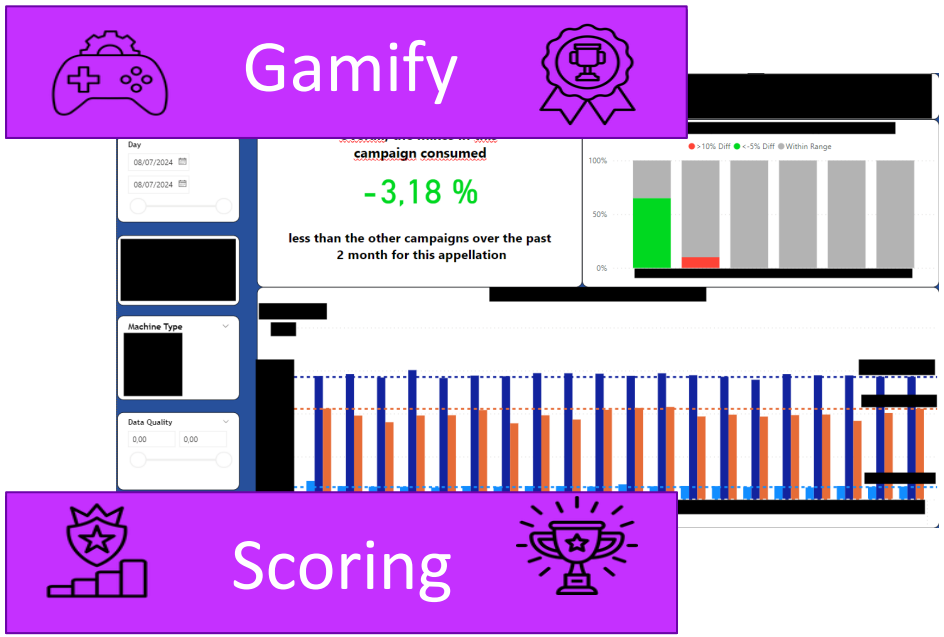


Operators to plant directors



Developed by:
Come Grienenberger
Full Stack Developer

Gamification solution



Developed by:
Yara Chidiac
Data Analyst

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Michelin progresses toward sustainability

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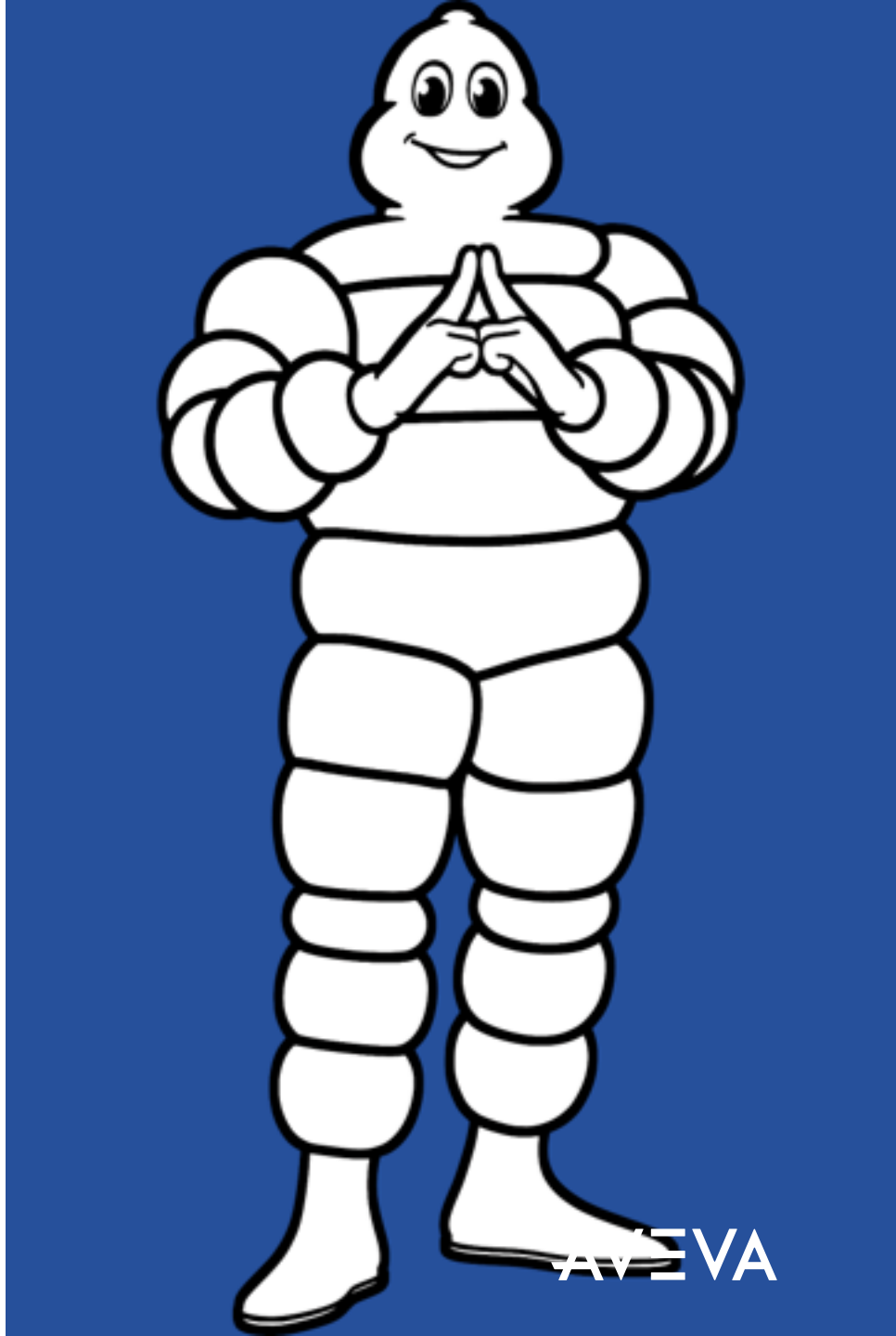
- Process huge amount of data.
- Make energy consumption monitoring accessible to everyone in the company.

Solution

- Use AVEVA PI Server and Asset Framework functionality combined with Michelin solution (Mapib) to read, standardize and contextualize data from each counter.
- Process data in the cloud and expose in a standard way for users.
- Develop a mobile app to offer quick and easy data access to everyone.

Results

- **Standardized data is coming to the cloud on 8 thousand counters and 15 sites.**
- **Data is available for use by every person onsite for monitoring of energy consumption.**
- **Benchmark between machines from different sites is available for central teams.**



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Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

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